Use of A-Train aerosol observations to constrain direct aerosol radiative effects (DARE) – comparisons with AeroCom models and uncertainty assessments

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We describe a technique for combining multiple A-Train aerosol data sets, namely MODIS spectral AOD (aerosol optical depth), OMI AAOD (absorption aerosol optical depth) and CALIOP aerosol backscatter retrievals (hereafter referred to as MOC retrievals) to estimate full spectral sets of aerosol radiative properties, and ultimately to calculate the 3-D distribution of direct aerosol radiative effects (DARE).

We present MOC results using almost two years of data collected in 2007 and 2008, and show comparisons of the aerosol radiative property estimates to collocated AERONET retrievals. Use of the MODIS Collection 6 AOD data derived with the dark target and deep blue algorithms has extended the coverage of the MOC retrievals towards higher latitudes. The MOC aerosol retrievals agree better with AERONET in terms of the single scattering albedo (ssa) at 441 nm than ssa calculated from OMI and MODIS data alone, indicating that CALIOP aerosol backscatter data contains information on aerosol absorption.

We compare the spatio-temporal distribution of the MOC retrievals and MOC-based calculations of seasonal clear-sky DARE to values derived from four models that participated in the Phase II AeroCom model intercomparison initiative. Overall, the MOC-based calculations of clear-sky DARE at TOA over land are smaller (less negative) than previous model or observational estimates due to the inclusion of more absorbing aerosol retrievals over brighter surfaces, not previously available for observationally-based estimates of DARE. MOC-based DARE estimates at the surface over land and total (land and ocean) DARE estimates at TOA are in between previous model and observational results. Comparisons of seasonal aerosol property to AeroCom Phase II results show generally good agreement – best agreement with forcing results at TOA is found with GMI-MerraV3.

We discuss sampling issues that affect the comparisons and the major challenges in extending our clear-sky DARE results to all-sky conditions. We present estimates of clear-sky and all-sky DARE and show uncertainties that stem from the assumptions in the spatial extrapolation and accuracy of aerosol and cloud properties, in the diurnal evolution of these properties, and in the radiative transfer calculations.